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INFLATABLE CURTAIN SUPPORT DEVICE

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INFLATABLE CURTAIN SUPPORT DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an inflatable curtain designed to protect the occupants of a vehicle during a side impact collision. More specifically, the invention relates to a device that reduces the inflation time of the inflatable curtain by providing column support during inflation.

2. Description of Related Art

In low-speed automobile collisions, occupants wearing safety belts are generally prevented from impact with the car's interior objects (*i.e.*, the windshield, instrument panel, or steering wheel). In more severe collisions, however, even belted occupants may impact the car's interior objects because their forward motion is so great that they contact these objects before the belts can bring them to a complete stop.

Conventional air bag systems were developed to supplement safety belts by reducing the chances of contact with the vehicle's interior objects. In addition, to the extent that such contact could not be prevented, conventional air bag systems were designed to distribute the impact more evenly over an occupant's head and torso.

A conventional air bag system typically consists of three parts: the air bag, the sensor, and the inflator. The air bag is typically made of a thin nylon fabric, which is folded into the steering wheel or dashboard. After impact of sufficient severity, sensors

1 in the vehicle detect the sudden deceleration and send an electrical signal to the inflator.
2 A chemical compound (*e.g.*, sodium azide, alcohol, hydrogen, compressed argon gas, or
3 the like) sealed inside the inflator then undergoes a rapid chemical reaction that produces
4 primarily nitrogen gas. The nitrogen gas inflates the air bag. As an occupant contacts the
5 air bag, the nitrogen gas is vented through openings in the sides of the bag, thus
6 absorbing the motion of the occupant's impact.

7 Vehicle manufacturers and suppliers have developed side impact air bag systems.
8 These air bag systems, which are commonly referred to as "inflatable cushions" or
9 "inflatable curtains," may be mounted within a housing located in the vehicle over the
10 doors, and may inflate during an accident to cover the windows, doors, and lateral
11 surfaces of the vehicle. The inflatable curtain may also be connected to tethers that
12 extend from the ends of the inflatable curtain to anchoring points within the vehicle.
13 These tethers may exert tension on the inflatable curtain to help maintain the position of
14 the inflatable curtain relative to the occupants of the vehicle.

15 Tethers may provide column support to the inflatable curtain during inflation. In
16 other words, tethers may help maintain the position of the inflatable curtain during
17 inflation, which tends to assist inflation of the inflatable curtain. Tether systems known
18 in the art have a number of disadvantages, however. Packaging the tethers is complicated
19 and expensive. In addition, adding tethers to an inflatable curtain is highly labor
20 intensive, as it may involve a great deal of sewing.

21 Accordingly, it would be an advancement in the art to provide a support device,
22 besides a tether, that can provide column support to a tetherless inflatable curtain and
23 reduce its inflation time. It would be a further advancement in the art to provide a

1 support device that can provide additional column support to an inflatable curtain having
2 one or more tethers. Additionally, it would be an advancement in the art to provide a
3 support device that can be added to an inflatable curtain with minimal expense. The
4 present invention provides these advancements in a novel and useful way.

5 6 SUMMARY OF THE INVENTION

7 The apparatus of the present invention has been developed in response to the
8 present state of the art, and in particular, in response to the problems and needs in the art
9 that have not yet been fully solved by currently available inflatable curtains. In
10 accordance with the invention embodied and broadly described herein, a novel inflatable
11 curtain support device to provide enhanced protection to the occupants of a vehicle
12 during a side impact collision is disclosed.

13 In accordance with the present invention, an inflatable curtain is provided. In one
14 embodiment, the inflatable curtain has a length greater than its width, an upper edge, and
15 four corners: an upper front corner, a lower front corner, an upper rear corner, and a
16 lower rear corner. A middle portion of the inflatable curtain is defined by a point
17 between the front edge and the rear edge. Of course, the inflatable curtain may be
18 generally square, oval, or any other desired shape.

19 The inflatable curtain includes an inflatable portion and a non-inflatable portion
20 which may be formed from separate sheets of material that are arranged in an overlying
21 manner and interconnected. Alternatively, the inflatable portion and non-inflatable
22 portion may be formed from a single sheet of material that is folded over and
23 interconnected.

1 An inflation inlet may be located on the upper edge of the inflatable curtain. The
2 inflation inlet is in communication with an inflator that contains a stored quantity of
3 pressurized inflation fluid. The inflator includes an output port which disseminates the
4 inflation fluid into the inflatable portion of the inflatable curtain. The inflator also
5 includes lead wires which enable the inflator to be in electrical communication with crash
6 sensors located within the vehicle. The inflator may contain more than one output port,
7 and the inflation inlet and inflator may be positioned toward either the upper rear corner
8 or upper front corner of the inflatable curtain. Also, the inflator may be in
9 communication with a fill tube that contains openings to provide fluid communication
10 between the fill tube and the inflatable curtain.

11 The inflatable curtain may include a tether positioned near the lower corner of the
12 inflatable curtain. Alternatively, the inflatable curtain may be tetherless, or it may
13 contain a plurality of tethers.

14 A first stiffening element having a first edge and a second edge may be positioned
15 in the upper rear corner of the inflatable curtain, and a second stiffening element having a
16 first edge and a second edge may be positioned in the upper front corner of the inflatable
17 curtain. In alternate embodiments, any number of stiffening elements may be used in
18 accordance with the present invention, and the stiffening elements may be positioned
19 anywhere along the peripheral region of the inflatable curtain.

20 The first and second stiffening elements may be plastic stays stitched to the
21 inflatable curtain. However, any type of semi-rigid material may be used for the first and
22 second stiffening elements, including elastomers, aluminum, or the like. In fact, the first
23 and second stiffening elements may be formed as integral portions of the inflatable

1 curtain. This may be accomplished by forming at least a portion of the upper edge of the
2 inflatable curtain out of a piece of semi-rigid fabric, interconnected fabric strips, or the
3 like.

4 There may be a need to securely fasten the first and second stiffening elements to
5 the inflatable curtain. This may be accomplished by any suitable fastening mechanism,
6 such as stitching or adhesive bonding. For example, a stiffening element may be stitched
7 to the inflatable curtain using a single stitch across the length of the stiffening element.
8 Alternatively, a stiffening element may be stitched to the inflatable curtain with a
9 plurality of stitches that are separated from one another by approximately one-half inch.

10 The first and second stiffening elements may remain substantially stationary with
11 respect to the length of the inflatable curtain when the inflatable portion is inflated. In
12 particular, neither the first or second edges of the first stiffening element, nor the first or
13 second edges of the second stiffening element, shift to a substantial degree with respect to
14 the length of the inflatable curtain when the inflatable portion is inflated.

15 The first and second stiffening elements may be generally elongated.
16 Alternatively, the first and second stiffening elements may be any desired shape, such as
17 circular or square. Also, the first and second stiffening elements may be oriented along
18 either the length or width of the inflatable curtain.

19 The inflatable curtain may be adapted to be stored within an interior portion of a
20 vehicle prior to inflation. The vehicle has a roof at its highest point, and a housing within
21 the vehicle and close to the roof defines an internal recess that may accommodate the
22 inflatable curtain prior to inflation. The housing may have a non-linear, elongated

1 configuration. The vehicle may also include a sensor mechanism, which is adapted to
2 sense a side impact to the vehicle

3 In one embodiment, a side impact of a magnitude greater than a predetermined
4 threshold value is sensed by the sensor mechanism, which then provides an electrical
5 signal to the inflator. The electrical signal causes the inflator to be actuated in a known
6 manner. The inflator discharges fluid under pressure into the inflatable portion of the
7 inflatable curtain. Shortly after the inflator discharges, the housing opens and the
8 inflatable curtain inflates away from the roof. The first and second stiffening elements
9 provide support to the inflatable curtain and reduce the amount of time it takes for the
10 inflatable curtain to become fully inflated.

11 These and other features and advantages of the present invention will become
12 more fully apparent from the following description and appended claims, or may be
13 learned by the practice of the invention as set forth hereinafter.

14 15 **BRIEF DESCRIPTION OF THE DRAWINGS**

16 In order that the manner in which the above-recited and other advantages and
17 objects of the invention are obtained will be readily understood, a more particular
18 description of the invention briefly described above will be rendered by reference to
19 specific embodiments thereof which are illustrated in the appended drawings.

20 Understanding that these drawings depict only typical embodiments of the invention and
21 are not therefore to be considered to be limiting of its scope, the invention will be
22 described and explained with additional specificity and detail through the use of the
23 accompanying drawings in which:

1 Figure 1 is a side cross-sectional view of an inflatable curtain in accordance with
2 the present invention;

3 Figure 2 is a side plan view of the interior of an automobile having an inflatable
4 curtain in accordance with the present invention prior to inflation;

5 Figure 3 is a side plan view of the interior of an automobile having an inflatable
6 curtain in accordance with the present invention after inflation;

7 Figure 4A is a top plan view of a portion of a stiffening element attached to the
8 inflatable curtain in accordance with the present invention; and

9 Figure 4B is a top plan view of a portion of a stiffening element attached to the
10 inflatable curtain in accordance with the present invention.

11
12 **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

13 The presently preferred embodiments of the present invention will be best
14 understood by reference to the drawings, wherein like parts are designated by like
15 numerals throughout. It will be readily understood that the components of the present
16 invention, as generally described and illustrated in the figures herein, could be arranged
17 and designed in a wide variety of different configurations. Thus, the following more
18 detailed description of the embodiments of the present invention, as represented in
19 Figures 1 through 4, is not intended to limit the scope of the invention, as claimed, but is
20 merely representative of presently preferred embodiments of the invention.

21 For example, for purposes of illustration and description, the embodiment
22 described below is used in conjunction with a side impact air bag system. However, the

1 present invention may be used in conjunction with any air bag system that utilizes an
2 inflatable curtain.

3 Referring now to Figure 1, there is shown a side cross-sectional view of an
4 inflatable curtain 10 having a longitudinal direction 12, a lateral direction 14, and a
5 transverse direction 16. The inflatable curtain 10 shown in Figure 1 may be constructed
6 of a nylon fabric that is coated with a gas impermeable material such as urethane or
7 silicone. Alternatively, the inflatable curtain may be constructed of elastomers, plastic
8 films, or any other suitable material.

9 The inflatable curtain 10 has an upper edge 18, a lower edge 20, a front edge 22,
10 and a rear edge 24. The inflatable curtain 10 has a generally rectangular shape with four
11 corners. An upper front corner 26 is defined by the intersection of the front edge 22 and
12 the upper edge 18; an upper rear corner 28 is defined by the intersection of the rear edge
13 24 and the upper edge 18; a lower front corner 30 is defined by the intersection of the
14 front edge 22 and the lower edge 20; and a lower rear corner 32 is defined by the
15 intersection of the rear edge 24 and the lower edge 20. A lower middle portion 34 is
16 defined by a point between the lower front corner 30 and the lower rear corner 32. The
17 inflatable curtain has a length 36 that is oriented in the lateral direction 14, and a width 38
18 that is oriented in the transverse direction 16. Of course, the inflatable curtain 10 may
19 take any desired shape. For example, the front edge 22 and rear edge 24 may be formed
20 by extending the upper edge 18 and lower edge 20 until they intersect.

21 The inflatable curtain 10 has an inflatable portion 40, having a plurality of
22 discrete inflatable cells 42, 44, 46, 48, 50, 52, 54, 56, 58, and 60. The discrete inflatable
23 cells 42, 44, 46, 48, 50, 52, 54, 56, 58, and 60 are distributed along the length 36 of the

1 inflatable curtain 10. In particular, moving left to right in a lateral direction from the
2 lower rear corner 32 of the inflatable curtain 10, six adjacent, discrete inflatable cells 42,
3 44, 46, 48, 50, and 52 are provided. Moving right to left in a lateral direction from the
4 lower front corner 30 of the inflatable curtain 10, four adjacent, discrete inflatable cells
5 54, 56, 58, and 60 are provided. Ten discrete inflatable cells 42, 44, 46, 48, 50, 52, 54,
6 56, 58, and 60 are shown for example purposes only; as many discrete inflatable cells as
7 needed may be provided. The inflatable curtain 10 also has a non-inflatable portion 62.

8 In Figure 1, the inflatable portion 40 and non-inflatable portion 62 are formed
9 from separate sheets of material that are arranged in an overlying manner and
10 interconnected. The separate sheets of material may be interconnected in any known
11 fashion, such as sewing or adhesive bonding. Of course, separate sheets of material need
12 not be used. For example, the inflatable portion 40 and non-inflatable portion 62 may be
13 formed from a single sheet of material that is folded over and interconnected.

14 The inflatable curtain 10 also includes a plurality of connectors 64, 66, 68, 70, 72,
15 and 74. As shown in Figure 1, the connectors 64, 66, 68, 70, 72, and 74 are small
16 extensions protruding from the upper edge 18 of the inflatable curtain 10. A suitable
17 fastening mechanism, such as a bolt, fits through each connector 64, 66, 68, 70, 72, and
18 74 to secure the inflatable curtain 10 to a vehicle.

19 An inflation inlet 76 protrudes from the upper edge 18 of the inflatable curtain 10.
20 The inflation inlet 76 is in communication with an inflator 78. In Figure 1, the inflator 78
21 contains a stored quantity of pressurized inflation fluid. However, the inflator 78 could
22 be of any suitable type or construction for supplying a medium for inflating the inflatable
23 portion 40 of the inflatable curtain 10. For example, the inflator 78 may contain a

1 combination of pressurized inflation fluid and ignitable material for heating the inflation
2 fluid. Alternatively, the inflator 78 may be a pyrotechnic inflator that uses the
3 combustion of gas-generating material to generate the inflation fluid.

4 In Figure 1, the inflation inlet 76 and inflator 78 are positioned on the upper edge
5 18 of the inflatable curtain 10, at a point located between the upper front corner 26 and
6 upper rear corner 28. However, the inflation inlet 76 and inflator 78 may be positioned in
7 any desired location. For example, the inflation inlet 76 and inflator 78 may be
8 positioned toward either the upper rear corner 28 or upper front corner 26 of the
9 inflatable curtain 10.

10 In Figure 1, the inflator 78 is in direct communication with the inflatable portion
11 40. In an alternate embodiment, the inflator 78 may be in communication with a fill tube,
12 the fill tube being an elastomeric inner tube with a reinforced outer sheath made of
13 braided or woven fabric, metal, plastic, rubber, nylon, or other suitable material. In such
14 an embodiment, the fill tube may contain openings that provide fluid communication
15 between the fill tube and the inflatable curtain 10. These openings may be non-uniformly
16 distributed because the pressure distribution of the inflation gases diminishes in relation
17 to the distance from the inflator 78. That is, the openings may be biased toward the part
18 of the inflatable curtain 10 farthest from the inflator 78.

19 Returning to the embodiment depicted in Figure 1, there is shown an output port
20 80 located on one end of the inflator 78. The output port 80, which is oriented in the
21 transverse direction 16, disseminates inflation fluid into the inflatable portion 40 of the
22 inflatable curtain 10. Of course, the output port 80 may be disposed toward either the
23 upper rear corner 28 or upper front corner 26 of the inflatable curtain 10, depending on

1 the location of the inflator 78. In addition, the inflator 78 may contain more than one
2 output port 80. For example, the inflator 78 may contain two output ports each oriented
3 in the lateral direction 14, secured to opposing sections of a segmented fill tube via an
4 adapter.

5 A mounting bracket 82 secures the inflator to a structural component located on a
6 vehicle, such as the vehicle's A-pillar, B-pillar, or C-pillar. The inflator 78 also includes
7 lead wires 84, which enable the inflator 78 to be in electrical communication with the
8 vehicle's crash sensors.

9 The inflatable curtain 10 also includes a tether 86, having a first end 88 and a
10 second end 90. For purposes of this application, the term "tether" should be interpreted
11 broadly, to encompass any flexible elongated member, such as a strip of rope, webbing,
12 cable, or any other suitable material. Also, although one tether 86 is shown in Figure 1,
13 the present invention is equally suitable for use with an inflatable curtain 10 that does not
14 contain any tethers 86, or that contains a plurality of tethers 86.

15 The tether 86 extends through a guide 92 located near the lower rear corner 32 of
16 the inflatable curtain 10. Although the guide 92 may be connected to the inflatable
17 curtain 10 at any desired location, it is preferably located at a point along the non-
18 inflatable portion 62 of the inflatable curtain 10. For example, the guide 92 may be
19 located near the lower edge 20 of the inflatable curtain 10 and spaced away from the rear
20 edge 24. Alternatively, the guide 92 may be located near the lower front corner 30, or in
21 any other suitable location. The guide 92 is preferably a one-way slider device
22 constructed such that the guide 92 slides easily over the tether 86 in a first direction, and

1 is blocked from sliding over the tether 86 in a second direction opposite the first
2 direction.

3 A first stiffening element 94 having a first edge 96 and a second edge 104 is
4 positioned in the upper rear corner 28 of the inflatable curtain 10. A second stiffening
5 element 100 having a first edge 102 and a second edge 104 is positioned in the upper
6 front corner 26 of the inflatable curtain 10. In Figure 1, the first stiffening element 94
7 and second stiffening element 100 are plastic stays stitched to the inflatable curtain 10.
8 However, any type of semi-rigid material may be used for the stiffening elements 94 and
9 100, including elastomers, aluminum, or the like, or combinations thereof. In fact, the
10 first and second stiffening elements 94 and 100 may be formed as integral portions of the
11 inflatable curtain 10. This may be accomplished by forming at least a portion of the
12 upper edge 18 of the inflatable curtain 10 out of a piece of semi-rigid fabric,
13 interconnected fabric strips, or the like.

14 It is preferable to position the first and second stiffening elements 94 and 100
15 along the upper edge 18 of the inflatable curtain 10. However, in accordance with the
16 present invention, the first and second stiffening elements 94 and 100 may be positioned
17 anywhere along the peripheral region of the inflatable curtain 10. When there is a need to
18 securely fasten the first and second stiffening elements 94 and 100 to the inflatable
19 curtain 10, any suitable fastening mechanism may be used. For example, the first and
20 second stiffening elements 94 and 100 may be stitched to the inflatable curtain 10.
21 Alternatively, the first and second stiffening elements 94 and 100 may be securely
22 fastened to the inflatable curtain 10 by adhesive bonding.

1 The first and second stiffening elements 94 and 100 may remain substantially
2 stationary with respect to the length of the inflatable curtain 10 when the inflatable
3 portion 40 is inflated. In particular, neither the first edge 96 or second edge 98 of the first
4 stiffening element 94, or the first edge 102 or second edge 104 of the second stiffening
5 element 100, shift to a substantial degree with respect to the length 36 of the inflatable
6 curtain 10 when the inflatable portion 40 is inflated.

7 Although two stiffening elements 94 and 100 are shown in Figure 1, any number
8 of stiffening elements may be used in accordance with the present invention. In addition,
9 although the first and second stiffening elements 94 and 100 are generally elongated, the
10 first and second stiffening elements 94 and 100 may be any desired shape, such as
11 circular or square. Also, in Figure 1, the first and second stiffening elements 94 and 100
12 are oriented along the length 36 of the inflatable curtain. However, the first and second
13 stiffening elements 94 and 100 may be elongated and oriented along the width 38 of the
14 inflatable curtain 10. In such an embodiment, it may be desirable to use more than one
15 stiffening element to provide increased support for the upper edge 18 of the inflatable
16 curtain 10.

17 Referring now to Figure 2, there is shown a side plan view of a vehicle 106
18 having an inflatable curtain 10 prior to inflation. The vehicle 106 includes a side portion
19 108, with a front window 110 and a rear window 112 positioned on the side portion 108.
20 A front door 114 is positioned beneath the front window 110, and a rear door 116 is
21 positioned beneath the rear window 112. A front seat 118 is positioned adjacent to the
22 front door 114, and a rear seat 120 is positioned adjacent to the rear door 116. A steering
23 wheel 122 is positioned in front of the front seat 118.

1 An A-pillar 124 is provided toward the front part of the front door 114. A B-
2 pillar 126 is provided between the front window 110 and the rear window 112. A C-
3 pillar 128 is provided toward the rear part of the rear door 116. A roof 130 is positioned
4 over the top of the vehicle 106.

5 A housing 132 defines an internal recess that accommodates the inflatable curtain
6 10 in the vehicle 106 prior to inflation. The housing 132 has a non-linear, elongated
7 configuration, originating at a point on the C-pillar 128 and extending along the roof 130.
8 The inflatable curtain 10 may be compacted by accordion folding, rolling, or any other
9 suitable method and stored in the housing prior to inflation. A plurality of fasteners 134,
10 136, 138, and 140 may be located on the housing 132 and used to secure the housing to
11 the vehicle 106.

12 When the inflatable curtain 10 is in its stored position prior to inflation, the first
13 end 88 of the tether 86 is secured to the housing 132. The second end 90 of the tether 86
14 is secured to a point on the C-pillar 128. Either end, however, may be secured to any
15 location that provides a structural linkage to the vehicle 106. Prior to inflation of the
16 inflatable curtain 10, at least a portion of the tether 86 is contained within the housing. In
17 Figure 2, the portion of the tether 86 contained within the housing 132 is shown by dotted
18 lines. The portion of the tether 86 not contained within the housing 132 is preferably
19 covered by a trim piece.

20 The vehicle 106 also includes a sensor mechanism 146, which is adapted to sense
21 a side impact to the vehicle. Lead wires 148 are attached to the sensor mechanism 146.
22 The lead wires 148 provide electrical communication between the sensor mechanism 146
23 and the inflator 78.

1 Referring generally to FIGS. 1-4, the operation of the present invention will be
2 described. In response to the sensing of a side impact of a magnitude greater than a
3 predetermined threshold value, the sensor mechanism 146 provides an electrical signal
4 over the lead wires 148 to the inflator 78. The electrical signal causes the inflator 78 to
5 be actuated in a known manner. The inflator 78 discharges fluid under pressure into the
6 inflatable portion 40 of the inflatable curtain 10.

7 Shortly after the inflator 78 discharges, the housing 132 opens and the inflatable
8 curtain 10 inflates away from the stored position in a transverse direction 16 away from
9 the roof 130. The inflatable curtain 10 does not inflate evenly, however. In particular,
10 the lower middle portion 34 of the inflatable curtain 10 reaches the first point 150 and the
11 lower rear corner 32 reaches the second point 152 while the lower front corner 30
12 remains substantially within the housing 132. The first and second stiffening elements 94
13 and 100 provide support to the inflatable curtain 10 and reduce the amount of time it
14 takes for the lower front corner 30 and lower rear corner 32 to reach the second and third
15 points 152 and 154.

16 Of course, the invention is not limited to two stiffening elements, and as many
17 stiffening elements as desired may be used. In addition, the stiffening elements 94 and
18 100 may be situated anywhere along the peripheral region of the inflatable curtain 10.
19 However, to provide the greatest column support and achieve the greatest reduction in the
20 inflation time of the inflatable curtain, the upper edge 18 of the inflatable curtain 10
21 should preferably be supported as much as possible.

22 From the above discussion, it will be appreciated that many of the problems
23 associated with known inflatable curtains, including tetherless inflatable curtains, are

1 addressed by the teachings of the present invention. The present invention provides one
2 or more stiffening elements that can provide column support to a tetherless inflatable
3 curtain and reduce its inflation time. However, a stiffening element in accordance with
4 the present invention is not limited to use with tetherless inflatable curtains, and can
5 provide additional column support to an inflatable curtain having one or more tethers.
6 Additionally, a stiffening element in accordance with the present invention may be added
7 to an inflatable curtain with minimal expense.

8 Of course, the present invention may be embodied in other specific forms without
9 departing from its essential characteristics as broadly described herein and claimed
10 hereinafter. The described embodiments are to be considered in all respects only as
11 illustrative, and not restrictive. The scope of the invention is, therefore, indicated by the
12 appended claims, rather than by the foregoing description. All changes that come within
13 the meaning and range of equivalency of the claims are to be embraced within their
14 scope.

15 What is claimed is: